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KS 184-3 (2012) (English): Primary batteries — Specification, Part 3: Watch batteries (Draft Standard)

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## PUBLIC REVIEW DRAFT KS184-3:2012, PRIMARY BATTERIES – PART 3: WATCH BATTERIES

This Draft Kenya Standard has been prepared by the Extra Low Voltage Equipment Technical Committee in accordance with the procedures of the Bureau, and is now being circulated for public comments.

The Committee would appreciate any comments on this Draft Standards, which should be submitted before **2012-05-05** using the attached template. It will also be appreciated if those who have no specific comments to make but find the draft standard generally acceptable can notify us accordingly. Absence of any reply or comments shall be deemed to be an acceptance of the technical contents of the draft Kenya standard and **shall constitute an approval vote**.

Suggestions entailing amendments of the text should include wording preferred and the relevant clause number quoted against any comments made.

**This draft standard is subject to change and should not be referred to or used as a Kenya Standard.**

All correspondence pertaining to this draft standard should be addressed to the Managing Director, Kenya Bureau of Standards for the attention of **Zacheus Mwatha**.

Yours faithfully,

Zacheus Mwatha
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**KS 184-3: 2012**
**IEC 60086-3: 2011**
ICS

# DRAFT KENYA STANDARD

## Primary batteries — Specification
## Part 3: Watch batteries

**PUBLIC REVIEW DRAFT, FEBRUARY 2012**

KENYA BUREAU OF STANDARDS (KEBS)

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Second Edition 2012

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Matatu Owners Association
Kenya Police
Ministry of Roads
Communications Commission of Kenya
National Communications Secretariat
Chloride Exide
Associated Battery Manufacturers East Africa Ltd.
Standard Chartered Bank
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## REVISION OF KENYA STANDARDS

**In order to keep abreast of progress in industry, Kenya standards shall be regularly reviewed. Suggestions for improvement to published standards, addressed to the Managing Director, Kenya Bureau of Standards, are welcome.**

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## FOREWORD

This Kenya Standard has been prepared by the Extra-Low Voltage Equipment Technical Committee under the guidance of the Electrical Industry Standards Committee and is in accordance with the procedures of the Bureau.

This is the first revision of KS 184 and in this revision the committee has retained the structure of IEC 60086 by covering the standard in 5 parts in separate documents, this part being Part 3, as follows:

KS04-184: Kenya Standard Specification for Primary Batteries.
- Part 1: General
- Part 2: Physical and electrical specifications
- **Part 3: Watch batteries**
- Part 4: Safety of lithium batteries
- Part 5: Safety of batteries with aqueous electrolyte

This Part 3 has been aligned with IEC 60086-3:2011. Where any text differs from the IEC text, this is indicated by a vertical line in the right hand margin.

Acknowledgement is hereby made for the use of IEC 60086-3:2011 in this standard.

For the purpose of this Kenya Standard, the source text should be/has been modified as follows:

(a) The words “this Kenya Standard” should replace “this International Standard” whenever they appear.

(b) A full point (.) has been used in place of a comma (,) when referring to a decimal marker.

(c)References to international standards should be replaced by references to the following equivalent Kenya Standards:

| Reference to International Standard | | Kenya Standard | |
|---|---|---|---|
| No. | Title | No. | Title |
| IEC 60086-2 | Primary batteries - Part 2: Physical and electrical specifications | KS 184: Part 2 | Primary batteries. Part 2: Physical and electrical specifications. |
| IEC 60086-3: 1995 | Primary batteries - Part 3: Watch batteries | KS 184: Part 3 | Primary batteries. Part 3: Watch batteries |
| IEC 60086-4: 2000 | Primary batteries - Part 4: Safety of lithium batteries | KS 184: Part 4 | Primary batteries. Part 4: Safety of lithium batteries |
| IEC 60086-5 | Primary batteries - Part 5: Safety of batteries with aqueous electrolyte | KS 184: Part 5 | Primary batteries. Part 5: Safety of batteries with aqueous electrolyte |
| IEC 60410: 1973 | Sampling plans and procedures for inspection by attributes. | - | - |

| | | | |
|---|---|---|---|
| IEC 61429: 1995 | Marking of secondary cells and batteries with the international recycling symbol ISO 7000-1135 | - | - |
| ISO 3951: 1989 | Sampling procedures and charts for inspection by variables for percent non-conforming. | KS ISO 3951 | Sampling procedures and charts for inspection by variables for percent non-confirming. |
| ISO/IEC Directives – Part 2: 1992 | | - | - |

This second edition cancels and replaces the first edition (2004) and constitutes a technical revision.

The major technical changes with respect to the previous edition are the drawings, a review of the table of electrochemical systems and a harmonization of the marking clause with the other standards of the IEC 60086 series. Moreover, the table of the leakage levels was extended by adding drawings with better visualization.

# INTRODUCTION

The technical content of this part of IEC 60086 provides specific requirements and information for primary watch batteries. This part was prepared through joint work between IEC TC 35 and ISO TC 114 to benefit primary battery users, watch designers and battery manufacturers by ensuring the best compatibility between batteries and watches.

This part will remain under continual scrutiny to ensure that the publication is kept up to date with the advances in both battery and watch technologies.

NOTE Safety information can be found in IEC 60086-4 and IEC 60086-5.

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# 1 Scope

This part of KS 184 specifies dimensions, designation, methods of tests and requirements for primary batteries for watches. In several cases, a menu of test methods is given. When presenting battery electrical characteristics and/or performance data, the manufacturer specifies which test method was used.

# 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

KS 184-1, *Primary batteries – Part 1: General*

KS 184-2, *Primary batteries – Part 2: Physical and electrical specifications*

KS 184-4, *Primary batteries – Part 4: Safety of lithium batteries*

KS 184-5, *Primary batteries – Part 5: Safety of batteries with aqueous electrolyte*

IEC 60410, *Sampling plans and procedures for inspection by attributes*

ISO 2859 (all parts), *Sampling procedures for inspection by attributes*

ISO 3951(all parts as applicable), *Sampling procedures for inspection by variables*

# 3 Terms and definitions

For the purposes of this document, the terms and definitions given in KS 184-1 as well as the following terms and definitions apply.

## 3.1

**capacitive reactance**

part of the internal resistance, that leads to a voltage drop during the first seconds under load

## 3.2

**capacity**

electric charge (quantity of electricity) which a cell or battery can deliver under specified discharge conditions

NOTE The SI unit for electric charge is the coulomb (1 C = 1 As) but, in practice, capacity is usually expressed in ampere hours (Ah).

## 3.3

**fresh battery**

undischarged battery 60 days maximum after date of manufacture

## 3.4

**ohmic drop**

part of the internal resistance that leads to a voltage drop immediately after switching the load on

# 4 Physical requirements

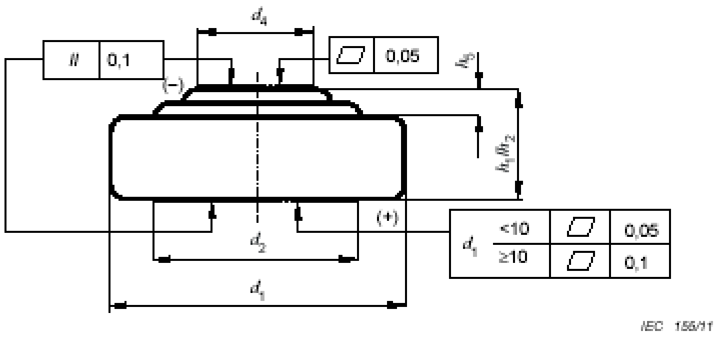
PRELIMINARY DRAFT

## 4.1 Battery dimensions, symbols and size codes

Dimensions and tolerances of batteries for watches shall be in accordance with Figure 1, Table 1 and Table 2. The dimensions of the batteries shall be tested in accordance with 7.1.

The symbols used to denote the various dimensions in Figure 1 are in accordance with KS 184-2, Clause 4.

*Dimensions in millimetres*



**Key**

| | |
|---|---|
| $h_1$ | maximum overall height of the battery |
| $h_2$ | minimum distance between the flats of the positive and negative contacts |
| $h_5$ | minimum projection of the flat negative contact |
| $d_1$ | maximum and minimum diameter of the battery |
| $d_2$ | minimum diameter of the flat positive contact |
| $d_4$ | minimum diameter of the flat negative contact |

NOTE This numbering follows the harmonization in the KS 184 series.

**Figure 1 – Dimensional drawing**

### Table 1 – Dimensions and size codes

Dimensions in millimetres

| Diameter | | | $d_4$ | Height $h_1/h_2$ | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Code[a] | $d_1$ | Tole-rance | | Code[a] | | | | | | | | | | | | | | |
| | | | | 10 | 12 | 14 | 16 | 20 | 21 | 25 | 26 | 27 | 30 | 31 | 32 | 36 | 42 | 54 |
| | | | | Tolerance | | | | | | | | | | | | | | |
| | | | | 0<br>−0,10 | 0<br>−0,15 | 0<br>−0,15 | 0<br>−0,18 | 0<br>−0,20 | 0<br>−0,20 | 0<br>−0,20 | 0<br>−0,20 | 0<br>−0,20 | 0<br>−0,25 | 0<br>−0,25 | 0<br>−0,25 | 0<br>−0,25 | 0<br>−0,25 | 0<br>−0,25 |
| 4 | 4,8 | 0<br>−0,15 | | | | | 1,65 | | 2,15 | | | | | | | | | |
| 5 | 5,8 | 0<br>−0,15 | 2,6 | 1,05 | 1,25 | 1,45 | 1,65 | | 2,15 | | | 2,70 | | | | | | |
| 6 | 6,8 | 0<br>−0,15 | 3,0 | 1,05 | 1,25 | 1,45 | 1,65 | | 2,15 | | 2,60 | | | | | | | |
| 7 | 7,9 | 0<br>−0,15 | 3,5 | 1,05 | 1,25 | 1,45 | 1,65 | | 2,10 | | 2,60 | | | 3,10 | | 3,60 | | 5,40 |
| 9 | 9,5 | 0<br>−0,15 | 4,5 | 1,05 | 1,25 | 1,45 | 1,65 | 2,05 | | | | 2,70 | | | | 3,60 | | |
| 11 | 11,6 | 0<br>−0,20 | 6,0 | 1,05 | 1,25 | 1,45 | 1,65 | 2,05 | | | 2,60 | | 3,05 | | | 3,60 | 4,20 | 5,40 |
| 12 | 12,5 | 0<br>−0,25 | 4,0 | | 1,20 | | 1,60 | 2,00 | | 2,50 | | | | | | | | |

NOTE Open boxes in the above matrix are not necessarily available for standardisation due to the concept of overlapping tolerances.

[a] See Annex A.

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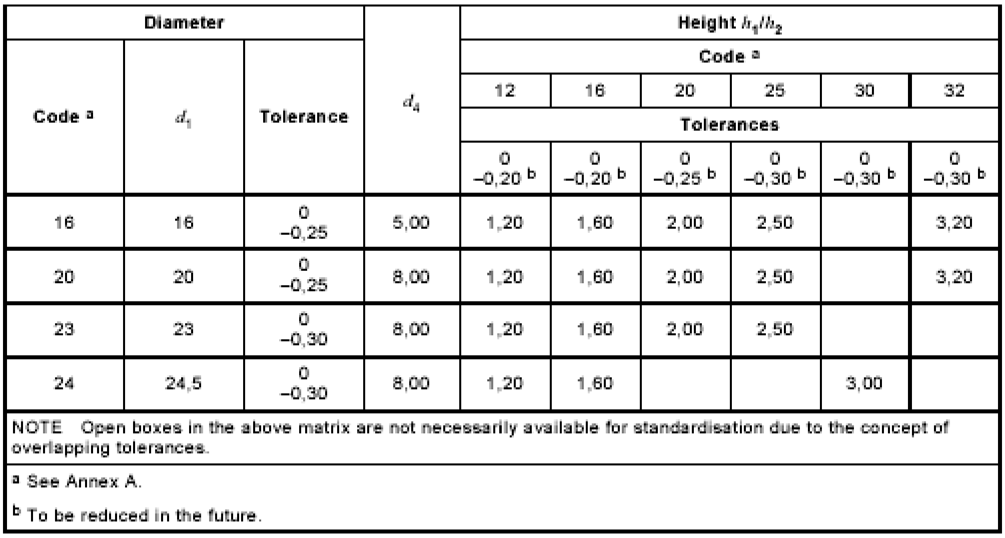
**Table 2 – Dimensions and size codes**

*Dimensions in millimetres*



| Diameter | | | $d_4$ | Height $h_1/h_2$ | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Code [a] | | | | | |
| Code [a] | $d_1$ | Tolerance | | 12 | 16 | 20 | 25 | 30 | 32 |
| | | | | Tolerances | | | | | |
| | | | | 0<br>−0,20 [b] | 0<br>−0,20 [b] | 0<br>−0,25 [b] | 0<br>−0,30 [b] | 0<br>−0,30 [b] | 0<br>−0,30 [b] |
| 16 | 16 | 0<br>−0,25 | 5,00 | 1,20 | 1,60 | 2,00 | 2,50 | | 3,20 |
| 20 | 20 | 0<br>−0,25 | 8,00 | 1,20 | 1,60 | 2,00 | 2,50 | | 3,20 |
| 23 | 23 | 0<br>−0,30 | 8,00 | 1,20 | 1,60 | 2,00 | 2,50 | | |
| 24 | 24,5 | 0<br>−0,30 | 8,00 | 1,20 | 1,60 | | | 3,00 | |

NOTE Open boxes in the above matrix are not necessarily available for standardisation due to the concept of overlapping tolerances.

[a] See Annex A.

[b] To be reduced in the future.

## 4.2 Terminals

Negative contact (–): the negative contact (dimension $d_4$) shall be in accordance with Tables 1 and 2. This is not applied to those batteries with a two-step negative contact.

Positive contact (+): the cylindrical surface is connected to the positive terminal. Positive contact should be made to the side of the battery but may be made to the base.

## 4.3 Projection of the negative terminal ($h_5$)

The dimension $h_5$ shall be as follows:

$h_5 \geq 0.02$ for $h_1/h_2 \leq 1.65$
$h_5 \geq 0.06$ for $1,65 < h_1/h_2 < 2.5$
$h_5 \geq 0.08$ for $h_1/h_2 \geq 2.5$

NOTE The negative contact should be the highest point of the battery.

## 4.4 Shape of negative terminal

The space requirements shall be contained within an angle of 45° (see Figure 2).

The minimum values of $l_1$, for different heights of $h_1/h_2$, are given in Table 3.

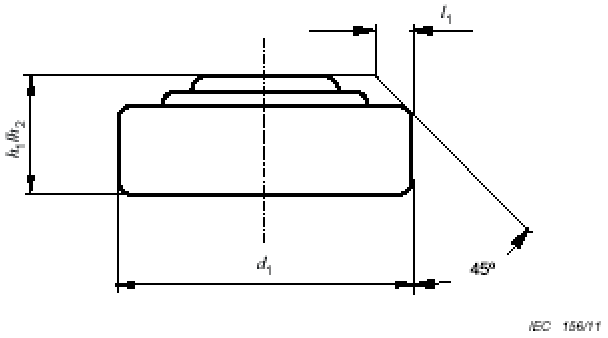


**Figure 2 – Shape of negative terminal**

**Table 3 – Minimum values of $l_1$**

*Dimensions in millimetres*

| $h_1/h_2$ | $l_{1\ \mathrm{min}}$ |
|---|---|
| $1 < h_1/h_2 \leq 1,90$ | 0,20 |
| $1,90 < h_1/h_2 \leq 3,10$ | 0,35 |
| $3,60 \leq h_1/h_2 \leq 4,20$ | 0,70 |
| $5,40 \leq h_1/h_2$ | 0,90 |

## 4.5 Mechanical resistance to pressure

A force *F* (N), as specified in Table 4, applied for 10 s through a steel ball of 1 mm diameter, at the centre of each contact area, shall not cause any deformation prejudicial to the proper functioning of the battery, i.e. after this test, the battery shall pass the tests specified in Clause 7.

**Table 4 – Applied force *F* by battery dimensions**

| Battery dimensions | | Force |
|---|---|---|
| $d_1$ mm | $h_1/h_2$ mm | $F$ N |
| <7,9 | <3,0 | 5 |
| | ≥3,0 | 10 |
| ≥7,9 | <3,0 | 10 |
| | ≥3,0 | 10 |

## 4.6 Deformation

The dimensions of batteries shall conform with the relevant specified dimensions at all times including discharge to the defined end-point voltage.

NOTE 1 A battery height increase up to 0,25 mm can occur in B, C, L and S systems, if discharged below this voltage.

NOTE 2 A battery height decrease can occur in B and C systems as discharge continues.

## 4.7 Leakage

Undischarged batteries and, if required, batteries tested according to 7.2.6 shall be examined as stated in 7.3. The acceptable number of defects shall be agreed between the manufacturer and the purchaser.

### 4.8 Marking

#### 4.8.1 General

The designation according to normative Annex A, or common and the polarity of the positive (+) terminal shall be marked on the battery whereas all the other markings below may be given on the immediate packing instead of on the battery. Any markings on the battery shall not impede electrical contact.

a) name or trademark of the manufacturer or supplier

b) Country of origin

c) date or manufacture code of two symbols;

The year and month or week of manufacture may be in code. The code is composed by the last digit of the year and by a number indicating the month. October, November and December should be represented by the letters O, Y and Z respectively.

EXAMPLE

41: January 2014;

4Y: November 2014.

d) the date by which the battery should be used can be indicated

nominal voltage;

e) name or trade mark of the supplier;

f) cautionary advice;

g) caution for ingestion of swallowable batteries shall be given. Refer to KS 184-4:2007 (7.2 m) and 9.2) and KS 184-5:- (7.1 l) and 9.2) for details.

#### 4.8.2 Disposal

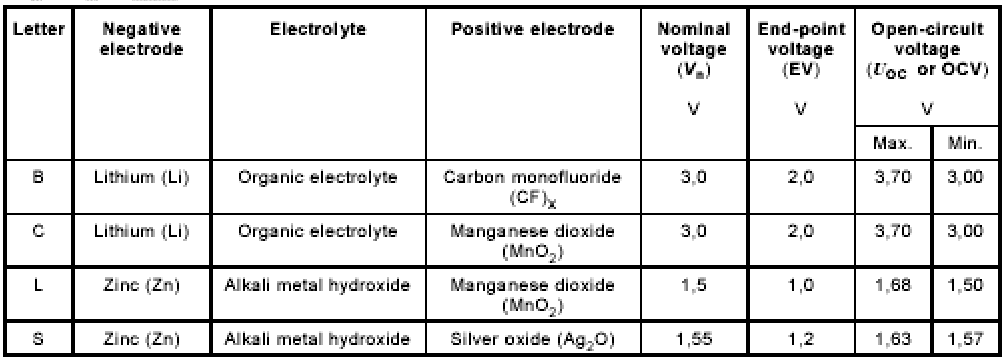
Marking of batteries with respect to the method of disposal shall be in accordance with local legal requirements.

## 5 Electrical requirements

### 5.1 Electrochemical system, nominal voltage, end-point voltage and open-circuit voltage

The requirements concerning the electrochemical system, the nominal voltage, the end-point voltage and the open-circuit voltage are given in Table 5.

**Table 5 – Standardised electrochemical systems**



| Letter | Negative electrode | Electrolyte | Positive electrode | Nominal voltage ($V_n$) V | End-point voltage (EV) V | Open-circuit voltage ($U_{OC}$ or OCV) V | |
|---|---|---|---|---|---|---|---|
| | | | | | | Max. | Min. |
| B | Lithium (Li) | Organic electrolyte | Carbon monofluoride $(CF)_x$ | 3,0 | 2,0 | 3,70 | 3,00 |
| C | Lithium (Li) | Organic electrolyte | Manganese dioxide ($MnO_2$) | 3,0 | 2,0 | 3,70 | 3,00 |
| L | Zinc (Zn) | Alkali metal hydroxide | Manganese dioxide ($MnO_2$) | 1,5 | 1,0 | 1,68 | 1,50 |
| S | Zinc (Zn) | Alkali metal hydroxide | Silver oxide ($Ag_2O$) | 1,55 | 1,2 | 1,63 | 1,57 |

### 5.2 Closed circuit voltage $U_{cc}$ (CCV), internal resistance and impedance

Closed circuit voltage and internal resistance shall be measured according to 7.2.

AC impedance should be measured with an LCR meter.

Limit values shall be agreed between the manufacturer and the purchaser.

### 5.3 Capacity

All batteries tested in accordance to clause 7.2.6 must meet the Minimum Average Duration as given in KS04-184 Primary Batteries. Part 2: Physical and electrical specifications.

### 5.4 Capacity retention

The capacity retention is the ratio between the capacities under the given discharge conditions measured on fresh batteries and a sample of the same lot stored during 365 days at (20 ± 2) °C and a relative humidity b etween 45 % and 75 %.

The ratio of capacity retention shall be agreed between the manufacturer and the purchaser. The minimum value should be at least 90 % for a period of 12 months. The capacity measurement is carried out according to 7.2.6.

## 6 Sampling and quality assurance

### 6.1 General

The use of sampling plans or product quality indices may be agreed between manufacturer and purchaser. Where no agreement is specified, the options in 6.2 and/or 6.3 are recommended.

### 6.2 Sampling

#### 6.2.1 Testing by attributes

When testing by attributes is required, the sampling plan chosen shall be in accordance with the specifications of IEC 60410 and/or ISO 2859. The individual parameters to be tested and the acceptance quality level (AQL) values shall be defined (a minimum of three batteries of the same type shall be tested).

#### 6.2.2 Testing by variables

When testing by variables is required, the sampling plan chosen shall be in accordance with ISO 3951. The individual parameters to be tested, the sample and the acceptance quality level (AQL) shall be defined.

### 6.3 Product quality indices

Consideration may be given to utilising one of the indices shown in KS 184-1.

## 7 Test methods

### 7.1 Shape and dimensions

#### 7.1.1 Shape requirement

The shape of the negative contact is checked preferably by optical projection or by an open gauge according to Figure 3.

The measurement method shall be agreed between the manufacturer and the purchaser.

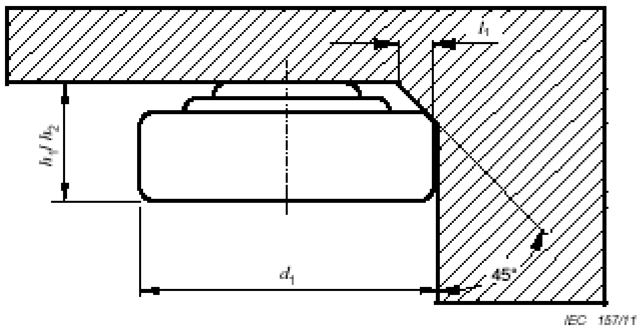


**Figure 3 – Shape requirement**

## 7.2 Electrical characteristics

### 7.2.1 Environmental conditions

Unless otherwise specified, the sample batteries shall be tested at a temperature of (20 ± 2) °C and a relative humidity between 45 % and 75 %.

During use, batteries may be exposed to low temperatures; it is therefore recommended to carry out complementary tests at (0 ± 2) °C and at (–10 ± 2) °C.

### 7.2.2 Equivalent circuit – effective internal resistance – DC method

Resistance of any electrical component determined by calculating the ratio between the voltage drop $\Delta U$ across this component and the range of current $\Delta\ i$ passing through this component and causing the voltage drop $R = \Delta U / \Delta i$.

NOTE As an analogy, the internal d.c. resistance $R_i$ of any electrochemical cell is defined by the following relation:

$$R_i\ (\Omega) = \frac{\Delta U\ (\mathrm{V})}{\Delta i\ (\mathrm{A})} \qquad (1)$$

The internal d.c. resistance is illustrated by the schematic voltage transient as given below in Figure 4.

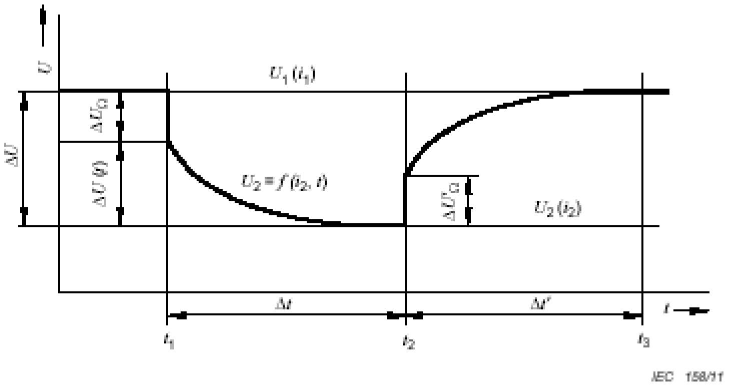


**Figure 4 – Schematic voltage transient**

As can be seen from this diagram, the voltage drop $\Delta U$ of the two components differs in nature, as shown in the following relation:

$\Delta U = \Delta U\Omega + \Delta U\ (t)$ (2)

The first component $\Delta U\Omega$ for ($t = t_1$) is independent of time (ohmic drop), and results from the increase in current $\Delta i$ according to the relation:

$\Delta U\Omega = \Delta i \times R\Omega$ (3)

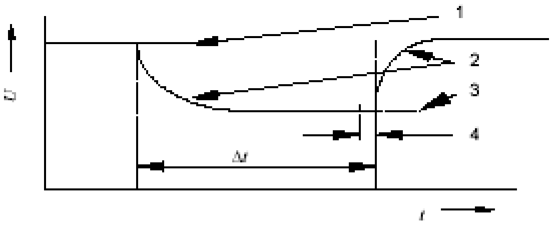
In this relation, $R\Omega$ is a pure ohmic resistance. The second component $\Delta U$ ($t$) is time dependent and is of electrochemical origin (capacitive reactance).

### 7.2.3 Equipment

The equipment used for the voltage measurements shall have the following specifications :

| | |
|---|---|
| - accuracy: | ≤0.25 %; |
| - precision: | ≤50 % of last digit; |
| - internal resistance: | ≥1 MΩ; |
| - measurement time: | in the tests proposed in the following subclauses, it is important to make sure that the measurement is taken during the flat period of the voltage transient (see Figure 5). Otherwise, a measurement error due to the capacitive reactance may occur (lower internal resistance). |

The time $\Delta t'$ necessary for the measurement shall be brief in comparison to $\Delta t$, and the measurement equipment compatible with these criteria.



IEC 159/11

**Key**

1 open-circuit voltage $U_{oc}$ (OCV)

2 effect of capacitive reactance

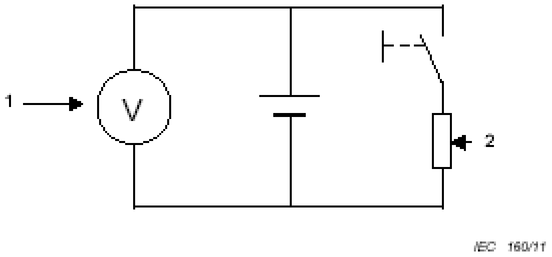
3 closed circuit voltage $U_{cc}$ (CCV)

4 $\Delta t'$ (measurement $U_{cc}$)

**Figure 5 – Curve: $U = f(t)$**

### 7.2.4 Measurement of open-circuit voltage $U_{oc}$ (OCV) and closed circuit voltage $U_{cc}$(CCV) (see Figure 6)

New circuit



**Key**

1 reading $U_{cc}$ / $U_{oc}$
2 $R_m$ resistance of measurement

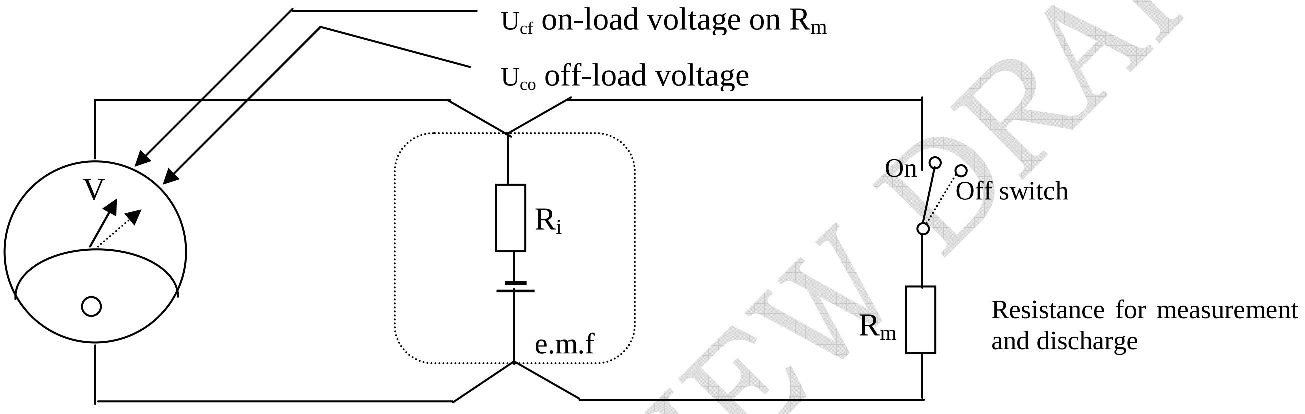
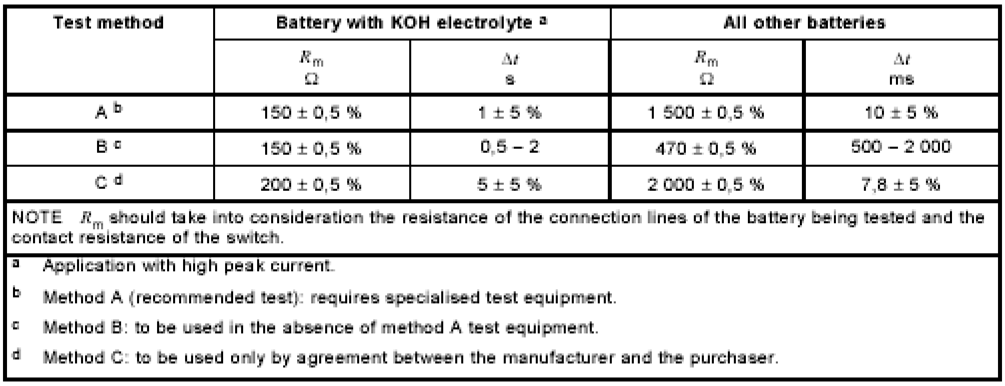

$U_{cf}$ on-load voltage on $R_m$
$U_{co}$ off-load voltage
V
$R_i$
e.m.f
On
Off switch
$R_m$
Resistance for measurement and discharge

Figure 6 – Circuitry principle

| | |
|---|---|
| First measurement | $U_{OC}$: The switch is left open while this measurement is being carried out. |
| Next measurement | $U_{cc}$: The battery being tested shall be connected to the load $R_m$. The switch shall be left closed during the duration $\Delta t$ according to Table 6. |

**Table 6 – Test method for $U_{CC}$ (CCV) measurement**



| Test method | Battery with KOH electrolyte [a] | | All other batteries | |
|---|---|---|---|---|
| | $R_m$ Ω | $\Delta t$ s | $R_m$ Ω | $\Delta t$ ms |
| A [b] | 150 ± 0,5 % | 1 ± 5 % | 1 500 ± 0,5 % | 10 ± 5 % |
| B [c] | 150 ± 0,5 % | 0,5 – 2 | 470 ± 0,5 % | 500 – 2 000 |
| C [d] | 200 ± 0,5 % | 5 ± 5 % | 2 000 ± 0,5 % | 7,8 ± 5 % |

NOTE $R_m$ should take into consideration the resistance of the connection lines of the battery being tested and the contact resistance of the switch.

[a] Application with high peak current.

[b] Method A (recommended test): requires specialised test equipment.

[c] Method B: to be used in the absence of method A test equipment.

[d] Method C: to be used only by agreement between the manufacturer and the purchaser.

### 7.2.5 Calculation of the internal resistance $R_i$

The internal resistance may be determined by the following calculation:

$$R_i = \frac{U_{oc} - U_{cc}}{U_{cc} / R_m}$$

NOTE The relation $U_{cc}/ R_m$ corresponds to the current delivered through the discharge resistance $R_m$ (see 7.2.4).

$$\frac{U_{co} - U_{cf}}{U_{cf} \ / R_m}$$

### 7.2.6 Measurement of the capacity

#### 7.2.6.1 General

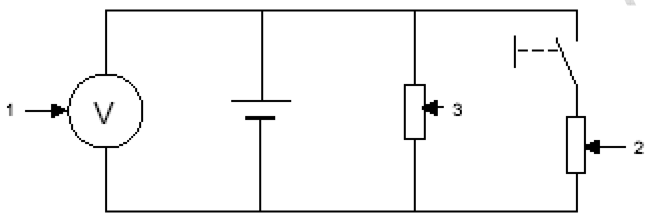
There are two methods for measuring capacity:

- the recommended method is method A, which is more indicative of watch requirements;
- method B is a more general method and is already specified in KS 184-1 and KS 184-2.

When presenting capacity data, the manufacturer shall specify which test method was used.

#### 7.2.6.2 Method A

a) Circuitry principle (see Figure 7)
proposed circuit



IEC 161/11

1 reading $U_{cc}/ U'_{oc}$
2 $R_m$ resistance of measurement
3 $R_d$ resistance of continuous discharge

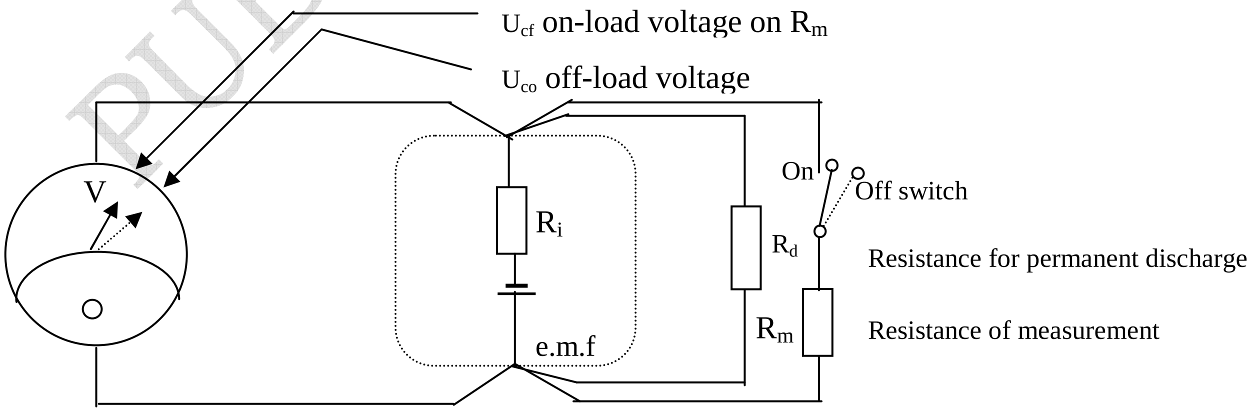

$U_{cf}$ on-load voltage on $R_m$
$U_{co}$ off-load voltage
V
$R_i$
e.m.f
On
Off switch
$R_d$
Resistance for permanent discharge
$R_m$
Resistance of measurement

Figure 7 – Circuitry principle for method A

b) Procedure

The duration of the discharge test at the resistor $R_d$ approximates to 30 days.

Value of the resistance $R_d$: the value of the resistive load (specified in Table 8) shall include all parts of the external circuit and shall be accurate to within ± 0,5 %.

c) Determination of the capacity

The measurements of the open-circuit voltage $U'_{oc}$ and that of the closed circuit voltage $U_{cc}$ are carried out at least once a day on the battery permanently connected to $R_d$, until the first passage of the $U_{cc}$ under the end-point voltage defined in Table 5 is obtained.

1) First measurement $U'_{oc}$: the resistance $R_d$ being much higher than $R_m$, $U'_{oc}$ approximates to $U_{OC}$.

   The switch is left open while the measurement is being carried out.

2) Next measurement $U_{cc}$: the battery being tested is connected to $R_m$. The switch is left closed during the duration $\Delta t$ according to Table 7.

**Table 7 – Test method A for $U_{cc}$ (CCV) measurement**

| Batteries with KOH electrolyte | | All other batteries | |
|---|---|---|---|
| $R_m$ Ω | $\Delta t$ s | $R_m$ Ω | $\Delta t$ ms |
| 150 ± 0,5 % | 1 ± 5 % | 1 500 ± 0,5 % | 10 ± 5 % |

NOTE 1 The value of resistive loads (which includes all parts of the external circuit) should be as specified in Table 7 and Table 8.

3) Calculation of the capacity $C$: the capacity of the battery is obtained by adding the partial capacity amounts $C_p$, calculated after each measurement with the following formula:

$$C_p = \frac{U'_{oc} \times t_i}{R_d}$$

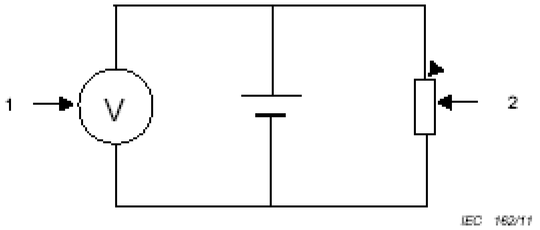
   where $t_i$ is the time between two measurements

$$C = \Sigma\, C_p$$

NOTE 2 At the end of the discharge, it is recommended to carry out several measurements a day in order to obtain sufficient accuracy.

### 7.2.6.3 Method B

a) Circuitry principle (see Figure 8)



1 reading $U_{cc}$
2 $R_d$ resistance of continuous discharge

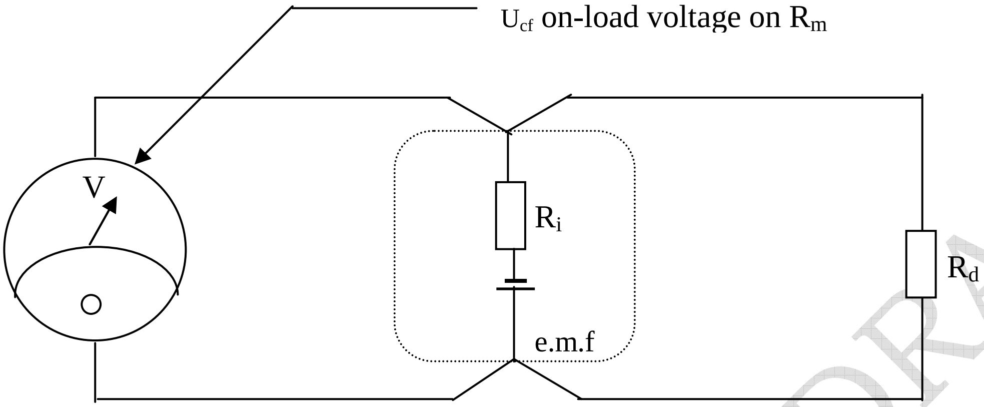


**Figure 8 – Circuitry principle for method B**

b) See procedure in 7.2.6.2 b).

c) Determination of the capacity: when the on-load voltage of the battery under test drops for the first time below the specified end point as specified in Table 5, the time *t* is calculated and defined as service life.

The capacity is calculated by the following formula:

$$C = \frac{U_{cc}\,(\text{average})}{R_d}\,t$$

where

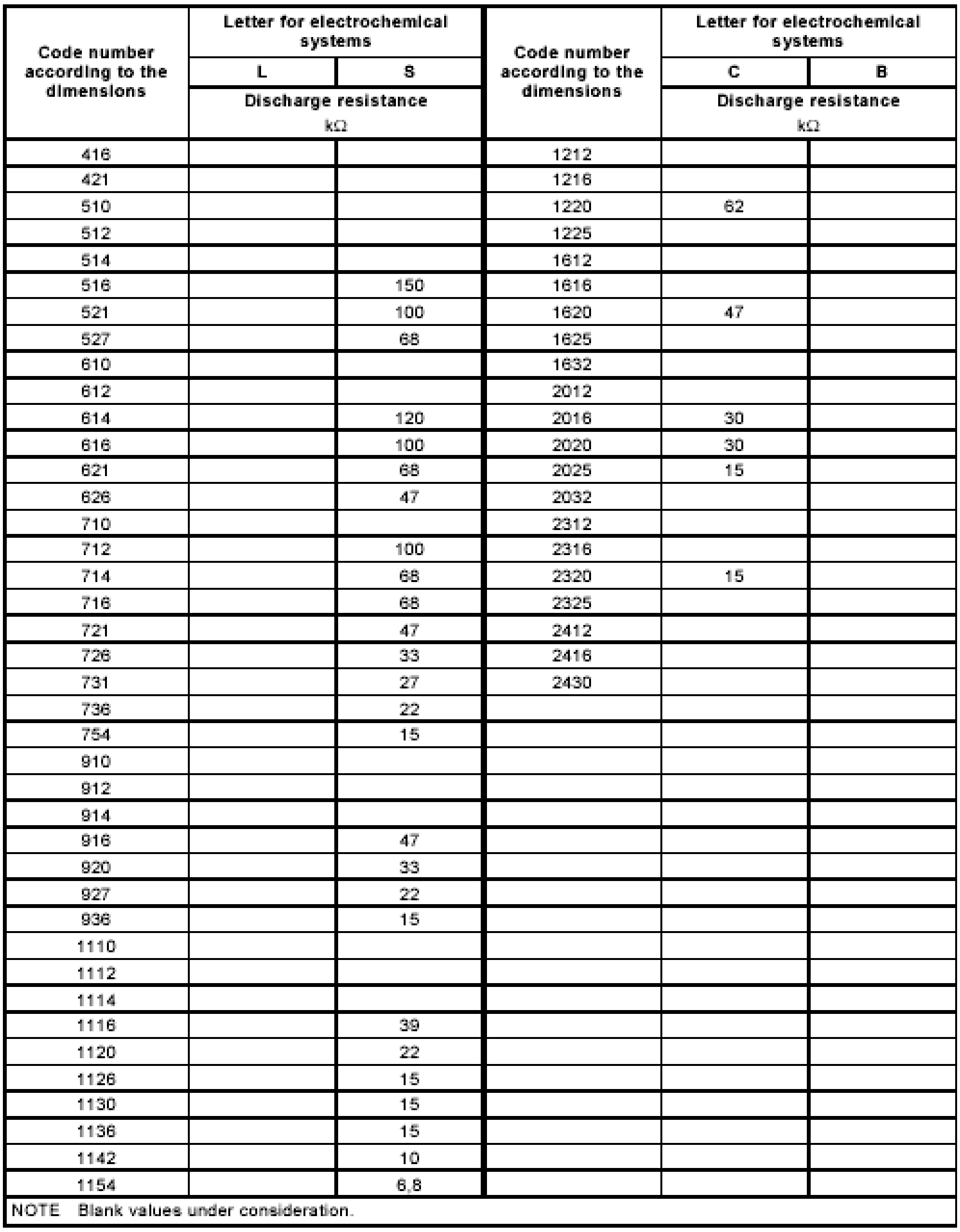
| | |
|---|---|
| *C* | is the capacity; |
| *U*cc(average) | is the average voltage value of *U*cc during discharge duration time (0-*t*); |
| *T* | is the service life. |

### 7.2.7 Calculation of the internal resistance $R_i$ during discharge in case of method A (optional)

After each measurement of *U'*oc and *U*cc is carried out according to the procedure described in 7.2.6, it is possible to calculate the internal resistance $R_i$ of the battery using the following formula:

$$R_i = \frac{U'_{oc} - U_{cc}}{U_{cc} / R_m}$$

Table 8 – Discharge resistance (values)



| Code number according to the dimensions | Letter for electrochemical systems | | Code number according to the dimensions | Letter for electrochemical systems | |
|---|---|---|---|---|---|
| | L | S | | C | B |
| | Discharge resistance kΩ | | | Discharge resistance kΩ | |
| 416 | | | 1212 | | |
| 421 | | | 1216 | | |
| 510 | | | 1220 | 62 | |
| 512 | | | 1225 | | |
| 514 | | | 1612 | | |
| 516 | | 150 | 1616 | | |
| 521 | | 100 | 1620 | 47 | |
| 527 | | 68 | 1625 | | |
| 610 | | | 1632 | | |
| 612 | | | 2012 | | |
| 614 | | 120 | 2016 | 30 | |
| 616 | | 100 | 2020 | 30 | |
| 621 | | 68 | 2025 | 15 | |
| 626 | | 47 | 2032 | | |
| 710 | | | 2312 | | |
| 712 | | 100 | 2316 | | |
| 714 | | 68 | 2320 | 15 | |
| 716 | | 68 | 2325 | | |
| 721 | | 47 | 2412 | | |
| 726 | | 33 | 2416 | | |
| 731 | | 27 | 2430 | | |
| 736 | | 22 | | | |
| 754 | | 15 | | | |
| 910 | | | | | |
| 912 | | | | | |
| 914 | | | | | |
| 916 | | 47 | | | |
| 920 | | 33 | | | |
| 927 | | 22 | | | |
| 936 | | 15 | | | |
| 1110 | | | | | |
| 1112 | | | | | |
| 1114 | | | | | |
| 1116 | | 39 | | | |
| 1120 | | 22 | | | |
| 1126 | | 15 | | | |
| 1130 | | 15 | | | |
| 1136 | | 15 | | | |
| 1142 | | 10 | | | |
| 1154 | | 6,8 | | | |

NOTE Blank values under consideration.

## 7.3 Test methods for determining the resistance to leakage

### 7.3.1 Preconditioning and previous examination

Before carrying out the tests specified in 7.3.2 and 7.3.3, the batteries shall be submitted to a visual examination according to the requirements stated in Clause 8.

For tests in 7.3.2.1 and 7.3.2.2, batteries shall be preconditioned at the specified temperature (40 °C and 45 ℃ respectively) for 2 h to avoid condensation at e levated humidity.

### 7.3.2 High temperature and humidity test

#### 7.3.2.1 Recommended test

The battery shall be stored under the conditions specified in Table 9.

**Table 9 – Storage conditions for the recommended test**

| Temperature<br>°C | Relative humidity<br>% | Test time<br>day |
|---|---|---|
| 40 ± 2 | 90 to 95 | 30 or 90 |
| NOTE The test time of 30 days may be used for an accelerated routine quality control test, whereas the test time of 90 days applies to qualification testing of new batteries. | | |

#### 7.3.2.2 Optional test

After agreement between the manufacturer and purchaser, the following testing conditions may be chosen (see Table 10).

**Table 10 – Storage conditions for optional test**

| Temperature<br>°C | Relative humidity<br>% | Test time<br>day |
|---|---|---|
| 45 ± 2 | 90 to 95 | 20 or 60 |
| NOTE The test time of 20 days may be used for an accelerated routine quality control test, whereas the test time of 60 days applies to qualification testing of new batteries. | | |

### 7.3.3 Test by temperature cycles

The battery shall be submitted to 150 temperature cycles according to the schedule in Figure 9:

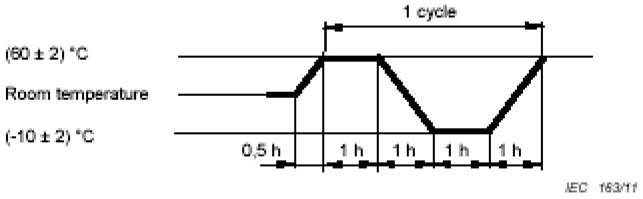


Figure 9 – Test by temperature cycles

The relative humidity shall be 50 % to 60 % at room temperature; it will subsequently vary with the temperature variation.

## 8 Visual examination and acceptance conditions

### 8.1 Preconditioning

Before carrying out the previous visual examination or after the tests specified in Clause 7, the batteries shall be stored for at least 24 h at room temperature and at a relative humidity between 45 % and 70 %.

NOTE 1 The leakage should, as a rule, be observed after crystallisation of the electrolyte. The time of the storage of 24 h can be prolonged if necessary.

NOTE 2 This examination may be applied to new or used batteries, or to batteries which have been submitted to different tests.

### 8.2 Magnification

The visual examination shall be carried out at a magnification of x10 to x15. The magnification of x15 is necessary in order to detect small leaks.

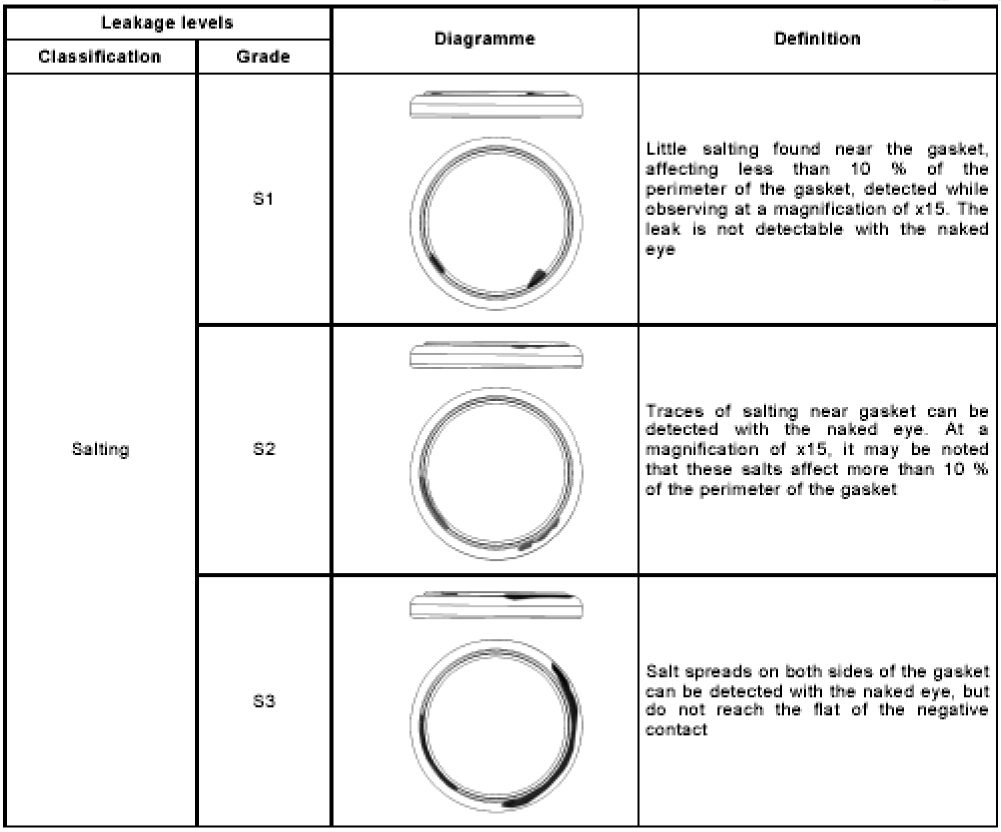
### 8.3 Lighting

The visual examination shall be carried out under a diffuse white light of 900 lx to 1 100 lx at the surface of the battery to be inspected.

### 8.4 Leakage levels and classification

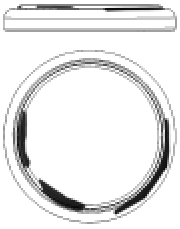
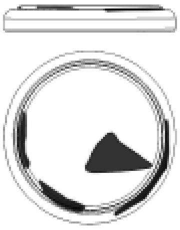
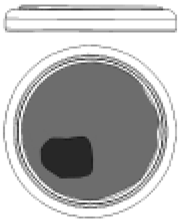
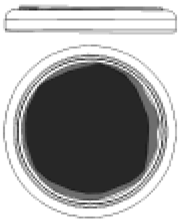
The leakage levels and classification are given in Table 11.

**Table 11 – Leakage levels and classification**



| Leakage levels | | Diagramme | Definition |
|---|---|---|---|
| Classification | Grade | | |
| Salting | S1 | | Little salting found near the gasket, affecting less than 10 % of the perimeter of the gasket, detected while observing at a magnification of x15. The leak is not detectable with the naked eye |
| | S2 | | Traces of salting near gasket can be detected with the naked eye. At a magnification of x15, it may be noted that these salts affect more than 10 % of the perimeter of the gasket |
| | S3 | | Salt spreads on both sides of the gasket can be detected with the naked eye, but do not reach the flat of the negative contact |

**Table 11 – Leakage levels and classification** (*continued*)

| Leakage levels | | Diagramme | Definition |
|---|---|---|---|
| Classification | Grade | | |
| Clouds | C1 |  | Leaks spread in clouds on both sides of the gasket, do reach the flat of the negative contact but do not reach the central part of the flat negative contact |
| | C2 |  | Leaks spread in clouds, which reach the central part of the flat negative contact |
| Leaks | L1 |  | The accumulation of crystallised liquid coming from the electrolyte swells up on part of the cloud spread, which covers the entire surface of the flat negative contact |
| | L2 |  | The accumulation of crystallised liquid coming from the electrolyte swells up on the entire cloud spread, which covers the entire surface of the flat negative contact |

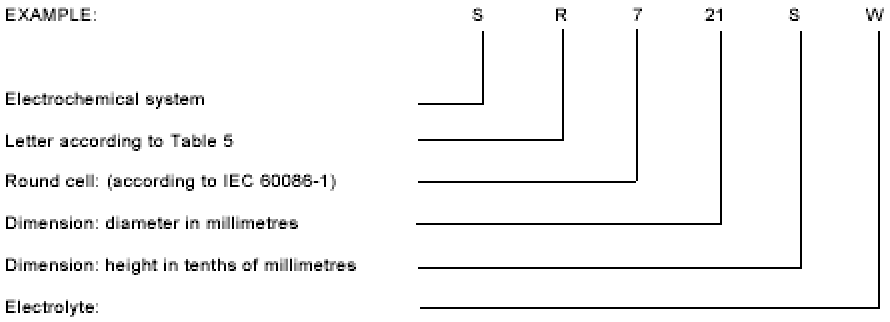
## 8.5 Acceptance conditions

The acceptable level, as well as the proportion of defective pieces, shall be agreed between the manufacturer and the purchaser.

Fresh batteries, with a level of leakage exceeding S1, shall not be submitted for qualification. The acceptance criteria may be less restrictive for batteries which have been tested according to 7.3.2. If necessary, photographic references may be established.

# Annex A
(normative)
## Designation

Watch batteries manufactured with the express purpose of complying with this standard should be designated by a system of coded letters and numbers as shown below. However, the letter W is used to indicate compliance with KS 184-3.


EXAMPLE:
S
R
7
21
S
W
Electrochemical system
Letter according to Table 5
Round cell: (according to IEC 60086-1)
Dimension: diameter in millimetres
Dimension: height in tenths of millimetres
Electrolyte:

- S: Sodium hydroxide NaOH (optional)
- P: Potassium hydroxide KOH (optional)

  Letter P may be left out in the case of electrochemical system letter S
- Organic electrolyte: null

Letter W: compliance with IEC 60086-3.

## Bibliography

IEC 60068-2-78:2001, *Environmental testing – Part 2-78: Tests – Test $C_a$: Damp heat, steady state*

ISO 8601:2004, *Data elements and interchange formats – Information interchange – Representation of dates and times*